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Initial and Continued Effects of a Release Spray in a Coastal Oregon Douglas-Fir Plantation

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Abstract

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Portions of a 4-year-old Douglas-fir (*Pseudotsuga menziesii* var. *menziesii* (Mirb.) Franco) plantation were sprayed with herbicide. Five years after spraying, we established 18 plots and used several means to determine retrospectively that six plots probably received full spray treatment and six others received no spray. Various portions of the remaining six plots probably were sprayed. Herbicide reduced number and size of red alder (*Alnus rubra* Bong.), increased number and size of planted Douglas-fir, damaged terminal shoots of Douglas-fir resulting in more abnormal boles and branching, and increased number of volunteer conifers.

Fifteen of the eighteen plots were thinned. In the subsequent 6 years, thinned plots that had received full release at age 4 averaged 9 percent more volume growth (all species) than plots not released.

Keywords: Conifer release, plantation growth, herbicide damage, *Pseudotsuga menziesii*, *Alnus rubra*, *Tsuga heterophylla*, *Picea sitchensis*, precommercial thinning, Oregon—Coast Ranges.

Summary

We evaluated slash burning and vegetation control as ways to delay rapid growth of residual and seral vegetation after clearcutting a productive site in the Oregon Coast Ranges. Following intensive slash burning, portions of a 4-year-old Douglas-fir (*Pseudotsuga menziesii* var. *menziesii* (Mirb.) Franco) plantation were sprayed with Esteron Brush Killer (1 lb per acre A.E. 2, 4-D and 1 lb per acre A.E. 2,4,5-T) in water. Five years after spraying, we established eighteen 0.20-acre plots and used several means to determine retrospectively that six plots probably received full spray treatment and six received no spray. Various portions of the remaining six plots probably were sprayed. The three groups differed significantly in average tree numbers, size, and species composition at plantation age 9, and the ranking of group means displayed a release effect. Because treatments were not assigned randomly among plots, cause of these differences is necessarily uncertain and judgmental. We infer that herbicide (1) reduced number and size of red alder (*Alnus rubra* Bong.), (2) increased number and size of planted Douglas-fir, (3) damaged terminal shoots of Douglas-fir resulting in more abnormal boles and branching, and (4) increased number of volunteer conifers. Natural regeneration converted this well-stocked Douglas-fir plantation to a mixed conifer-red alder stand.

Fifteen of the eighteen plots were thinned to 300 Douglas-fir per acre, with an additional 0 to 80 red alder per acre retained for controlled comparisons. On the six herbicide-released plots, residual trees averaged larger size and 33 percent greater total volume immediately after thinning. In the subsequent 6 years and after covariance adjustment of observed means for differences in after-thinning volume among the three herbicide treatments, thinned plots that had received full release at age 4 averaged 9 percent more volume growth (all species) than plots not released. Volume growth differed significantly and treatment means followed a logical progression. The 15-year trends of tree and stand growth in this plantation suggested that a herbicidal release-spray 4 years after planting improves survival and growth of planted Douglas-fir in the subsequent 11 years.

Introduction

Rapid growth of residual and seral vegetation after clearcutting is characteristic of productive sites in the Oregon Coast Ranges. The resulting threat to full and uniform stocking of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii* (Mirb.) Franco) plantations has concerned local foresters for decades (Howard and Newton 1984, Ruth 1956, Stein,[1] Stewart and others 1984, Walstad and others 1986). To counter this threat, several strategies have been developed and used with varying success. These include (1) controlling vegetation by site preparation; (2) planting large seedlings capable of outgrowing competitors, rather than planting smaller stock or depending on natural regeneration; (3) protecting seedlings from animal-caused damage; and (4) using herbicide sprays or manual cutting to release seedlings from vegetative competition. These and other reforestation tactics have been discussed by Stewart (1978), Stavins and others (1981), Knapp and others (1984), Walstad and Kuch (1987).

We describe individual and cumulative effects of typical reforestation and early silviculture through release and precommercial thinning at a site II location near the Oregon coast. We report effects of herbicide release on tree numbers, size, and species composition on 18 plots through plantation age 9 years, and growth in volume and height through 15 years.

Methods

Location

The study area is a Douglas-fir plantation in the Waldport Ranger District, Siuslaw National Forest (fig. 1). Topography sampled by study plots has northerly, easterly, and westerly aspects, elevations ranging between 600 and 1,000 feet, and slopes ranging between 5 and 70 percent.

Soils[2]

Most plots are located on Slickrock gravelly clay loam developing from sandstone colluvium of an ancient land flow. Portions of some plots are located either on Bohannon gravelly loam, a residual soil also developing on sandstone, or on an intergrade between the two series. Slickrock soils differ from Bohannon by being deeper than 48 inches and having finer textures. Both are Andic Haplumbrepts of the fine-loamy, mixed, mesic family.

Stand

The 50-acre plantation was auger-planted in January 1971 with 2-1 Douglas-fir of a local seed source. Nominal spacing was 10 feet by 10 feet. The preceding stand was old-growth Douglas-fir and western hemlock (*Tsuga heterophylla* (Raf.) Sarg) that was logged in 1969. Site preparation consisted of the following activities:

August 1969—Preburn spray (2 lb per acre of A.E. Amitrol-T in water; 10 gal of mix per acre).[3]

[1] Stein, W.I. 1986. Manual and chemical options for releasing Douglas-fir from competing brush in Oregon's Coast Range. 22 p. Research progress report. On file with: Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331.

[2] Bush, George. March 4, 1980. Soils report—Risley Creek area, Siuslaw National Forest. On file with: Pacific Northwest Research Station, 3625 93d Avenue, SW, Olympia, WA 98512-9193.

[3] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

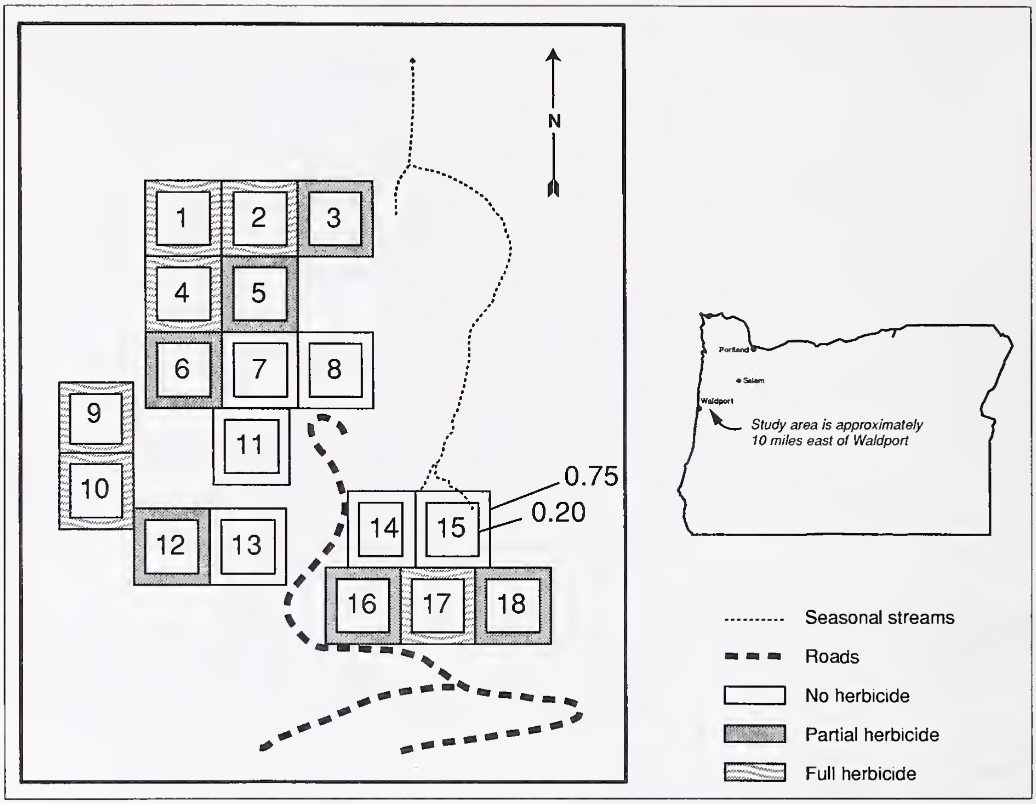

Figure 1—Plot locations and size (acres) in the experimental area.

May 1970—Preburn spray (1 lb per acre of A.E. 2,4-D + 1 lb per acre and A.E. 2,4,5-T in water; 10 gallons of mix per acre).

August 1970—Broadcast burned; the fire consumed forest floor, twigs, and branches over nearly all the unit.

On May 31, 1975,[4] about 30 acres, mostly at lower elevations, of the 4-year-old plantation were aerially sprayed with Esteron Brush Killer (1 lb per acre each of A.E., 2,4-D and 2,4,5-T) in water. Upper elevations of the unit were not sprayed for release because conifer bud burst had progressed so that spray damage was likely.

After the 1979 growing season, 18 square areas, each 0.75 acre, were established to test six silvicultural regimes in the 9-year-old plantation.[5] A 0.2-acre tree measurement plot was centered within each square (fig. 1). The possibility that a given plot

[4] Stand Improvement Record, Bayview Compartment no. 5201, Unit 711, Cell 31C3. The spray evaluation (2 months later) concluded that 75 percent of the sprayed area had nearly complete kill but some resprouting, and the rest of the spray area had stems with more than half the wood dead and no resprouting.

[5] Miller, R.E.; Obermeyer, E.L. Comparative effects of thinning, urea fertilizer, and red alder in a site II, coast Douglas-fir plantation. Study plan. On file with: Forestry Sciences Laboratory, 3625 93d Avenue, SW, Olympia, WA 98512-9193.

had been sprayed was judged by four methods: (1) the District's spray map,[6] (2) reduced diameter growth in 1975 as measured in 10 to 20 felled or bored red alders per plot, (3) documentary photographs from 1976, and (4) plot-by-plot inspection for crown and bole abnormalities in fall 1979. Based on the four types of evidence, we classified plots into three groups: those whose trees received no herbicide, some herbicide, or full herbicide treatment. Fortuitously, six plots qualified for each group, so the six silvicultural regimes could each be randomly assigned within each herbicide-release group. Fifteen of the areas were thinned to retain 300 Douglas-fir per acre and 0-80 red alder (*Alnus rubra* Bong.) per acre. Three areas remained nonthinned. Treatments were randomly assigned with the exception of one plot that had no red alder, yet was randomly assigned to retain 20 alder per acre. Treatments were switched between this and another plot.

Tree Measurements and Summaries

Trees designated for cut were tallied by 1-inch diameter at breast height (d.b.h.) classes. All noncut trees with a d.b.h. of 0.1 inch and larger were tagged and their d.b.h. measured to the nearest 0.1 inch. Past and current heights were measured on 30 Douglas-fir and current height on 8 to 16 red alder per plot (including buffer if necessary); trees were remeasured 3 and 6 years later. Total stem volume, including tip and stump, was calculated for each tree from height-d.b.h. equations and regional volume equations appropriate for each species. Volume equations included those for Douglas-fir (Bruce and DeMars 1974), western hemlock (Wiley and others 1978), and other species (Browne 1962).

Statistical Analysis

The experimental design was assumed as completely randomized, with six replications of each treatment. In statistical analyses of tree numbers and sizes, three categories of probable treatment were designated as no release, partial release, or full release. Significant means identified by analysis of variance were separated by the Sheffé test. Because treatments were retrospectively determined, however, tests were conditional (hypothesis building) rather than valid tests of hypotheses.

Results and Discussion

Plantation Age 9 Years

Before thinning—Although originally planted to about 435 Douglas-fir per acre, the 9-year-old plantation averaged 480 Douglas-fir, 1.6 inch and larger, and an additional 1,045 per acre (218 percent) that were 0.1 to 1.5 inch d.b.h. (table 1). Other conifer species (mostly western hemlock and Sitka spruce [*Picea sitchensis* (Bong.) Carr.]) in these two size classes averaged 42 and 926 per acre, respectively. Corresponding numbers of red alder averaged 109 and 60 per acre . Douglas-fir, mostly planted, was clearly the dominant species in the 1.6 inch and larger d.b.h. class. Assuming a planting of 435 trees per acre, natural regeneration increased stocking on average by 196 trees per acre (45 percent) in the 1.6 inch and larger size classes and by 2,228 per acre (512 percent) in trees 0.1 inch and larger (table 1). Natural regeneration converted this Douglas-fir plantation to a mixed conifer-red alder stand.

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[6] Map and report on file with Waldport Ranger District, Waldport, OR 97394.

Table 1—Number of trees, by species, at 9 years and herbicide treatment at year 4, per acre basis[a]

		Tree diameters[b]							
		0.1 inch and larger				1.6 inches and larger			
Release treatment	Plot no.	DF	RA	WH+SS	All[c]	DF	RA	WH+SS	All[c]
		Number							
None	7	1020	110	120	1250	475	65	5	545
	8	970	230	570	1770	420	110	20	550
	11	1165	100	145	1410	425	30	80	535
	13	1370	285	215	1870	465	160	15	640
	14	1125	185	605	1915	455	150	50	655
	15	1445	185	1665	3295	385	150	0	535
	Mean	**1182a**	**182a**	**553a**	**1918a**	**438b**	**111a**	**28a**	**577a**
Partial	3	1010	95	1035	2140	445	55	110	610
	5	1240	0	705	1950	440	0	25	465
	6	1160	80	270	1510	430	45	45	520
	12	2140	410	195	2745	515	290	0	805
	16	1745	295	1240	3280	540	210	30	780
	18	2610	100	3000	5710	445	75	50	570
	Mean	**1651a**	**163a**	**1074a**	**2889a**	**469ab**	**112a**	**43a**	**625a**
Full	1	1435	0	1935	3370	590	0	85	675
	2	1580	0	1495	3075	445	0	30	475
	4	1390	0	1070	2460	555	0	50	605
	9	1200	270	260	1730	470	125	0	595
	10	2465	380	630	375	570	270	35	875
	17	2385	320	2275	4985	565	230	130	930
	Mean	**1742a**	**162a**	**1277a**	**3182a**	**532a**	**104a**	**55a**	**692a**
All	**Mean**	**1525**	**169**	**968**	**2663**	**480**	**109**	**42**	**631**

[a] Within diameter classes, treatment means for a given species not sharing the same letter are statistically different ($P \leq 0.10$).
[b] DF = Douglas-fir, RA = red alder, WH = western hemlock, SS = Sitka spruce.
[c] Sum of individual species may not equal the total (All) because of rounding errors and presence of nonspecified species.

Analysis of variance showed significant differences among the three groups in number of Douglas-fir 1.6 inches in d.b.h. and larger (table 2). Plots receiving full treatments averaged 21 percent more Douglas-fir trees and 31 percent greater volume. Mean number and volume of the other conifers in this size class, however, did not differ among the treatments. Although differences in total number and volume of red alder among the treatment groups were not statistically significant, mean d.b.h. of red alder in fully released plots averaged 62 percent smaller ($P \leq 0.04$). This suggests that alder were damaged or killed by herbicide, and some subsequently recovered or were replaced by younger alder.

Table 2—Stand statistics before thinning at plantation age 9, by release treatment and species, trees 1.6 inches in d.b.h. and larger[a]

	No release[b]			Partial release[b]			Full release[b]			P-value ≤		
Item	DF	RA	All	DF	RA[c]	All	DF	RA[c]	All	DF	RA	All
Stems (no./acre)	438b	111	577	469ab	112	625	532a	104	692	0.01	0.99	0.34
Volume:												
Cubic feet/acre	268	80	353	329	74	413	352	45	406	.11	.67	.59
Percent	100	100	100	123	92	117	131	56	115	—	—	—
Dq (inch)	3.4	3.2a	3.4	3.6	2.5ab	3.5	3.5	1.3b	3.4	.47	.04	.49
H40 (feet)	24.0	—	—	24.7	—	—	24.4	—	—	.78	—	—
BH age (years)	5.9	—	—	6.2	—	—	6.3	—	—	.35	—	—
Abnormal boles[d] (no./acre)	17	—	—	30	—	—	48	—	—	.11	—	—

[a] Treatment means for a given species not sharing the same letters are statistically different, $P \leq 0.10$.
[b] DF = Douglas-fir, RA = red alder, All = all species.
[c] Red alder not found in 1 of 6 of the partial-release plots, and in 3 of 6 of the full-release plots.
[d] Average number of DF crop trees (total = 300 per acre) with boles crooked or deformed in 1974 or 1975, or both.

At plantation age 9, average height of the 40 largest Douglas-fir per acre, H_{40}, was about 25 feet for all groups, and breast height (b.h.) age averaged about 6 years. Trends suggested that released trees attained b.h. about 0.4 year earlier, but differences were statistically nonsignificant. Similarities in height and age among release groups at age 9 implied that 50-year site index (King 1966) and inherent site productivity also would be similar among the plots. As indicated by greater incidence of abnormal bole form and branching tallied in 1979, nearly threefold more trees given full release had leader damage ($P \geq 0.11$, table 2). This corroborated the opinion of the herbicide specialist.[7]

Although statistical tests indicated some real differences existing among the three groups, justifiable doubt remains about herbicide being the sole cause of these differences. Some differences in stand phenology and growth existed before herbicide was applied; that is, herbicide purposefully was not sprayed where bud-burst of Douglas-fir had occurred or was imminent. This raises reasonable questions about the initial similarity of sprayed and nonsprayed areas in microclimate, soil, and vegetative cover. The similar height-age relations at age 9, however, suggest that differences in inherent site quality did not explain the differences in tree size and stand volume among the release groups.

We believe that differences resulted largely from herbicide treatment because (1) the partial-release group generally has stand statistics intermediate to the other two groups, and (2) stand statistics among the three groups follow expected consequences of herbicide treatment, namely:

1. Only some of the plots treated with herbicide at age 4 had no red alder 5 years later (table 1). Conversely, all nonreleased plots had at least 100 alder per acre before thinning. Moreover, quadratic mean d.b.h. (Dg) of alder in herbicide-treated plots averaged much smaller in treated than in nontreated plots, indicating that alders were either injured or killed and replaced by younger volunteers at a later date (table 2).

[7] Personal communication. 1985. Howard Weatherly, forestry technician and herbicide specialist, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331.

Table 3—Number of trees cut or retained by plot, species, and release treatment at plantation age 9, per acre basis[a]

Release treatment	Plot no.	Cut trees 0.1 inch and larger DF	RA	WH+SS	All[b]	Leave trees 1.6 inches and larger DF	RA	WH+SS	All[b]
		Number							
None	7	725	90	115	930	275	20	5	300
	8	680	190	565	1435	285	35	5	325
	11	855	100	145	1100	300	0	0	300
	13	1070	285	215	1570	285	0	0	285
	14	820	115	605	1540	300	70	0	370
	Mean	**830**	**156**	**329**	**1315**	**289**	**25**	**2**	**316**
Partial	3	700	95	1035	1830	305	0	0	305
	5	935	0	705	1645	300	0	0	300
	6	875	45	270	1190	280	25	0	305
	12	1850	330	195	2375	280	80	0	360
	16	1445	275	1240	2960	295	20	0	315
	Mean	**1161**	**149**	**689**	**2000**	**292**	**25**	**0**	**317**
Full	1	1130	0	1930	3060	305	0	0	305
	4	1085	0	1065	2150	305	0	0	305
	9	895	230	260	1385	305	30	0	335
	10	2170	355	630	3155	285	25	0	310
	17	2075	240	2275	4590	310	75	5	390
	Mean	**1471**	**165**	**1232**	**2868**	**302**	**26**	**1**	**329**
All	**Mean**	**1154**	**157**	**750**	**2061**	**294**	**25**	**1**	**320**

[a] DF = Douglas-fir, RA = red alder, WH = western hemlock, SS = Sitka spruce.
[b] Sum of individual species may not equal the total (All) because of rounding errors and nonspecified species.

2. Herbicide-treated plots had more coniferous stems, especially in trees less than 1.6 inches d.b.h. (table 1). This seems reasonable, because by killing red alder and other competing vegetation, herbicide provides openings for establishing additional natural regeneration.

3. Herbicide-treated plots had more conifers attaining 1.6 inches d.b.h. by plantation age 9 years (table 1).

After thinning—In each release group, one plot remained nonthinned and the other five plots were thinned nominally to 300 Douglas-fir per acre, with an additional 0 to 80 red alder per acre retained to create a controlled comparison of alder-Douglas-fir combinations. Because earlier release stimulated natural regeneration, group means show a consistent pattern: 52 percent more trees were cut (or poisoned if red alder) on partially released plots and 118 percent more on fully released plots than those not released (table 3). Alternately expressed as a percentage of the average pre-thinning number of trees (thinned plots only), 80 percent was cut or poisoned in nonreleased plots vs. 86 percent and 90 percent in the partially and fully released plots, respectively.

Table 4—Average after-thinning volume and annual net change in stand statistics for thinned plots during a 6-year period (1979-85) by original herbicide-release groups and by species, trees 1.6 inches in d.b.h. and larger[a]

Release treatment or species	Starting volume	Mean annual growth (volume growth) Unadjusted	Adjusted[b]		H_{40}[c]
	----- Cubic feet/acre -----			Percent	Feet
			Douglas-fir (DF)		
None	198b	136b	154b	100	2.70a
Partial	250ab	160ab	156b	101	2.77a
Full	277a	186a	172a	112	2.80a
			Red alder (RA)		
None	25a	20a	19a	100	—
Partial	25a	19a	17a	89	—
Full	20a	16a	18a	95	—
			All species (All)		
None	224a	156b	174b	100	—
Partial	275a	178ab	174b	100	—
Full	297a	202a	189a	109	—
			Statistical significance ($P \leq$)		
DF	0.08	0.02	0.12	—	0.90
RA	.96	.96	.70	—	—
All	.18	.06	.06	—	—

[a] Treatment means for a given species not sharing the same letter are statistically different ($\leq$ 0.10).
[b] Adjusted by covariance using starting volume as covariate.
[c] H_{40} = average height of the 40 largest Douglas-fir per acre.

Growth From Age 9 Through 15

Between the age of 9 and 15 years (table 4), thinned stands that had received full release at age 4 averaged 29 percent more volume growth (all species) than stands not released (202 vs. 156 $ft^3 \bullet acre^{-1} \bullet year^{-1}$). Corresponding unadjusted Douglas-fir volume growth was 37 percent greater on plots fully treated with herbicide. These differences were statistically significant, and treatment means again follow a logical progression (table 4). The greater volume growth on plots released by herbicide treatment at plantation age 4 could be explained by (1) slightly greater thinning intensity, hence release at age 9, and (2) 40 percent more Douglas-fir volume and 33 percent more all-species volume immediately after thinning (table 4). Because the percentage increases in growth after thinning were similar to the percentage differences in residual stand volume after thinning, we used initial volume as a covariate to adjust growth (fig. 2). This adjustment reduced the magnitude of growth differences among the three treatment means, but the means retained a logical progression and statistically significant differences (table 4).

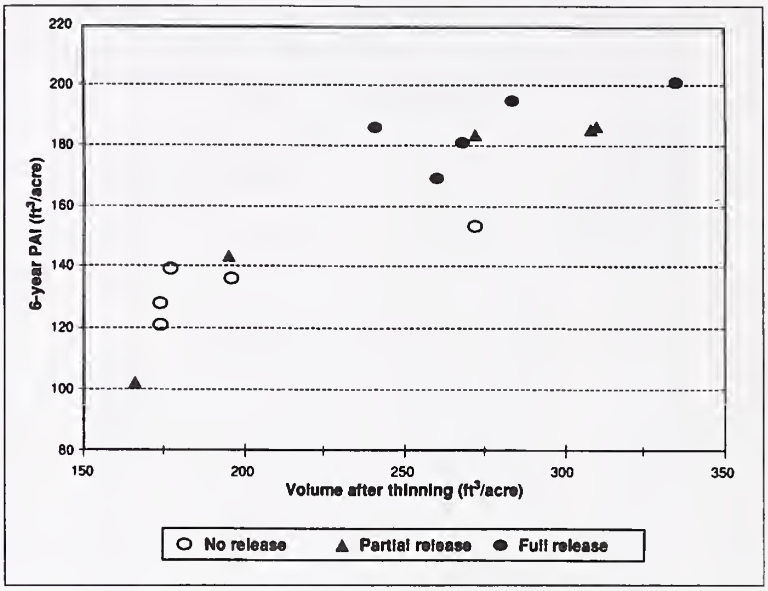

Figure 2—Periodic annual net volume growth in a 6-year period after thinning and an earlier herbicide-release spray.

We infer that herbicide release-spray reduced numbers and growth of red alder and greatly increased the number of naturally regenerated Douglas-fir, western hemlock, and Sitka spruce. Therefore when plots were thinned to similar numbers of residual conifers, thinning intensity or degree of release averaged more in herbicide-treated areas. Moreover, residuals were larger, which implied residual effect of herbicide. The alternate explanation of site quality differences favoring herbicide-treated plots is unlikely because height and height growth among the treatments were similar. None of the initially largest trees was cut or died, so sample trees were consistent. The greater average volume growth on herbicide-treated plots could be a residual consequence of this treatment on tree numbers, size, and spacing and, in part, reflected greater release and especially after-thinning volume at age 9. We have no firm explanation for continued, more rapid volume growth of herbicide-treated plots.

Implications

Although differences exist among the three herbicide-release groups, we cannot be certain that these differences were caused by early release spray. The pattern and biological reasonableness of the results, however, encourage us to conclude that herbicide sprays contributed strongly to increased conifer density, size, and volume growth through age 15.

The large variation in topography in this 50-acre study area is typical of many sites in the Oregon Coast Ranges. This variation in slope and aspect undoubtedly inflated experimental error, thereby reducing likelihood of detecting statistical significance among the three groups. On the positive side, however, those differences that were significant (tree numbers and total volume of several species) indicated robust treatment effects and, hence, justify applying these findings to other sites.

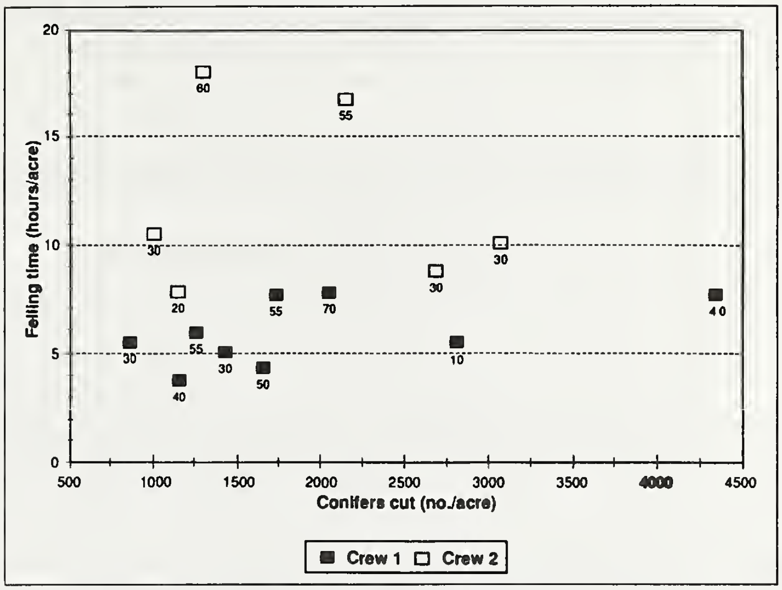

Figure 3—Time requirements by two different crews to thin plots in a 9-year-old plantation to 300 stems per acre. Numbers under the boxes are slope percent for each plot.

Did enhanced stocking, however, increase time required to thin the 9-year-old plantation? Figure 3 shows felling time required by crew 1 and crew 2 to reduce conifer stocking on fifteen 0.75-acre plots (each containing a 0.20-acre measurement plot from which stem number per acre was derived). Crop trees in the interior measurement plots were premarked to indicate which conifers to retain; crews were directed to retain similar spacings of residual conifers in the buffer areas and not to cut any red alder because they subsequently would be poisoned by hack-and-squirt methods. The two crews thinned some plots in each release group. Time requirements per acre for both crews seem to increase (1) with number of stems cut and (2) with slope percent. Clearly, however, (3) the faster crew required about one-half as much time as the slower to fell a comparable number of trees on comparable slope positions. Although density of salmonberry (*Rubus spectabilis*) and Himalayan blackberry (*R. procerus*) also affected thinning costs on these plots, their density and effects were not quantified.

Operational experience in the last decade at the Waldport District suggests that costs of precommercial thinning would not increase detectably if tree numbers were doubled or even tripled by herbicide treatment. In dense stands, volunteer conifers would generally be smaller and thus require less felling effort. Unless stands are grossly overstocked (dog-hair), however, past costs of thinning contracts have depended closely on stand accessibility, amount of understory vegetation, and slope percent.

Conclusions

Because herbicide treatments were not assigned randomly among these plots, our assignment of cause for differences among the three treatment groups is necessarily uncertain and judgmental. We infer, however, that:

1. Herbicides reduced number and size of red alder.

2. Herbicides increased number and size of Douglas-fir, but increased incidence of abnormal boles and branching.

3. Herbicides increased number of volunteer conifers.

4. Herbicides increased stand volume yield through age 15.

These inferences correspond to hypotheses that could be supported by examining existing stands retrospectively or by direct testing through controlling treatments in an experimental design. The magnitude of the potentially negative effects of herbicide release on increased incidence of abnormal boles and branching or increased number of conifers, as measured at this study area, does not seem to justify further concern or need for further research.

Acknowledgments

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Conversion Table

When you know:	Multiply by:	To find:
Inches (in)	2.54	Centimeters
Feet (ft)	0.3048	Meters
Acres	0.4047	Hectares
Cubic feet (ft^3)	0.02832	Cubic meters
Cubic feet/acre (ft^3/acre)	0.6997	Cubic meters/hectare
Pounds (lb)	0.45	Kilograms
Pound/acre (lb/acre)	1.12	Kilograms/hectare
Gallons (gal)	3.79	Liters

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Portions of a 4-year-old Douglas-fir (*Pseudotsuga menziesii* var. *menziesii* (Mirb.) Franco) plantation were sprayed with herbicide. Five years after spraying, we established 18 plots and used several means to determine retrospectively that six plots probably received full spray treatment and six others received no spray. Various portions of the remaining six plots probably were sprayed. Herbicide reduced number and size of red alder (*Alnus rubra* Bong.), increased number and size of planted Douglas-fir, damaged terminal shoots of Douglas-fir resulting in more abnormal boles and branching, and increased number of volunteer conifers.

Fifteen of the eighteen plots were thinned. In the subsequent 6 years, thinned plots that had received full release at age 4 averaged 9 percent more volume growth (all species) than plots not released.

Keywords: Conifer release, plantation growth, herbicide damage, *Pseudotsuga menziesii*, *Alnus rubra*, *Tsuga heterophylla*, *Picea sitchensis*, precommercial thinning, Oregon—Coast Ranges.

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